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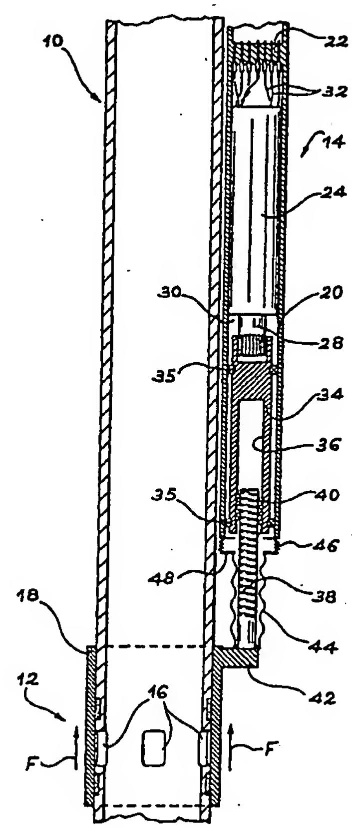
(54) Title: A DOWNHOLE ACTUATOR INCLUDING A SEALING BELLOWS

(57) Abstract

An actuator (14) designed to remain without maintenance down a well for a prolonged period includes at least one sealing bellows (44) and, preferably, a compensation bellows (46), between the fluid in the well and an internal chamber (30) filled with hydraulic fluid. The bellows (44, 46) make it possible either to omit dynamic elastomer gaskets or to protect them from the environment. The actuator (14) which is, for example, of the electromechanical type, may in particular drive an adjustable–aperture valve (12). The two bellows (44, 46) are advantageously made of stainless steel. They may be mounted either end–to–end, or else be totally dissociated.



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A DOWNHOLE ACTUATOR INCLUDING A SEALING BELLOWS

DESCRIPTION

Technical field

The present invention relates to an actuator designed to be placed permanently down an oil or gas well in production, so as to cause a moving part to move therein at will.

Such an actuator may, in particular, be used to drive an on-off valve, a variable flow rate valve or any other device that needs to remain down a well for a prolonged period, e.g. for about 5 years, without undergoing any maintenance.

The invention also relates to a flow-rate adjusting device equipped with such an actuator.

State of the art

Regardless of their functions, actuators currently used in downhole installations are generally equipped with dynamic sealing gaskets, interposed between the moving portions and the stationary portions of the actuators.

In particular, dynamic sealing gaskets are used both on hydraulic actuators and also on electromechanical actuators incorporating electric motors and screw-and-nut systems.

When frequent maintenance is possible, elastomer sealing gaskets are used, such gaskets offering excellent sealing levels but requiring frequent replacement.

When it is desirable for maintenance operations to be spaced apart in time, elastomer gaskets are usually replaced with gaskets of different types and shapes, such as metal or thermoplastic gaskets. Unfortunately, although the life-span of such gaskets is longer than that of elastomer gaskets, they must nevertheless be

replaced relatively frequently, in particular because of the especially severe temperature conditions (150°C to 175°C) and pressure conditions (1000 bars to 1500 bars) prevailing at the bottom of the well, of the corrosive nature of the fluid from the well, and of the frequent presence of sand and of gravel.

Regardless of the type of gasket used, it is essential for the actuator to be properly sealed during the entire period between two consecutive maintenance operations. The slightest drop of well fluid penetrating into the actuator could make said actuator unusable, e.g. by causing a short-circuit.

In order to equalize the very high downhole pressure, most of the actuators operating in this environment contain a hydraulic fluid. A compensation device is then associated with the actuator so as to take pressure and temperature variations into account, and so as to equalize continuously the pressure of the well fluid and the pressure of the hydraulic fluid contained in the actuator. Generally, the compensation device is also equipped with dynamic gaskets which suffer from problems similar to those of the gaskets with which the actuator proper is equipped.

Summary of the invention

An object of the invention is to provide an actuator designed to be capable of remaining down a well with no maintenance for a period much longer than the period made possible with existing actuators, e.g. for about 5 years.

According to the invention, this result is achieved by means of a downhole actuator including drive means suitable for moving a moving member relative to a stationary housing in a longitudinal direction of the well, at least one zone of the housing containing a fluid at a pressure substantially equal to the pressure down the well, said actuator being characterized in that it further includes at least one sealing bellows interposed

in said direction between the housing and the moving member, the sealing bellows defining at least a portion of said zone.

By using at least one bellows for sealing the actuator, it is possible either to omit the dynamic sealing gaskets commonly used for this purpose, or to protect them from the downhole atmosphere, if they cannot be omitted. When they are not omitted, the gaskets are no longer in direct contact with the downhole fluid.

Preferably, the actuator further includes a compensation bellows connected to said zone, and including a radial wall subjected to the downhole pressure.

By using a bellows for compensating the variations in pressure and in temperature in the well, it is possible to perform this function while omitting all of the dynamic sealing gaskets used in existing compensation devices.

In a first embodiment of the invention, the sealing bellows and the compensation bellows are mounted in end-to-end alignment. One end of the compensation bellows is then fixed to the housing, and the sealing bellows connects the moving member to the rim of a central opening provided in the radial wall of the compensation bellows.

In a second embodiment of the invention, the sealing bellows and the compensation bellows are separate. The sealing bellows then connects the moving member to the housing, and the compensation bellows communicates separately with the above-mentioned zone of the housing.

In which case, various configurations are possible depending on the location of the moving member relative to the stationary housing.

Thus, the moving member may be placed beyond one end of the stationary housing. A single sealing bellows then connects the moving member to said end of the housing.

In which case, that end of the compensation bellows which is opposite from the radial wall is fixed either to one end of the housing, or to a portion of the moving member that is situated outside the housing. In which case, a duct is provided through the housing or through the moving member to connect the above-mentioned zone to the compensation bellows.

The moving member may also be placed facing an opening provided in the stationary housing. Two sealing bellows then connect the moving member to the housing, on respective sides of the opening. In which case, the volume of the zone filled with hydraulic fluid remains substantially constant.

In which case, that end of the compensation bellows which is opposite from the radial wall is fixed to an end of the housing, and communicates with said zone.

Advantageously, the sealing bellows and the compensation bellows are made of stainless steel.

The actuator may, in particular be of the electromechanical type. In which case, the drive means comprise an electric motor housed in the housing, and an intermediate member is rotatably mounted in the housing, and is suitable for being rotated by the electric motor. Said intermediate member is then engaged on the moving member via a screw-and-nut type coupling.

In general, the cylinder may either be fixed to one side of the segment of production tubing and parallel thereto, or else surround said segment coaxially.

The actuator may also be of the hydraulic type. The drive means then comprise a hydraulic actuator actuated by a pressure source. In which case, the moving member is secured to a piston of the actuator, which piston is suitable for sliding in fluid-tight manner in said housing while defining at least one drive chamber connected to the pressure source. The above-mentioned zone is then formed outside said chamber, is separated therefrom by at least one sealing gasket, and is

connected to a fluid tank defined at least in part by the compensation bellows.

The invention also provides a device for adjusting downhole flow rate, said device including an actuator, a segment of production tubing in which at least one opening is provided, and a sleeve mounted to slide relative to said segment, the actuator including drive means suitable for moving a moving member secured to said sleeve relative to a stationary housing secured to said segment in a longitudinal direction of the well, at least one zone of the actuator containing a fluid at a pressure substantially equal to the downhole pressure, said device being characterized in that it further includes at least one sealing bellows interposed in said direction between the housing and the moving member, the sealing bellows defining at least one portion of said zone.

Brief description of the drawings

Various embodiments of the invention are described below by way of non-limiting example and with reference to the accompanying drawings, in which:

Figure 1 is a longitudinal section view of a downhole actuator of the electromechanical type, equipped with two sealing bellows mounted end-to-end, in a first embodiment of the invention;

Figure 2 is a view on a larger scale of the two bellows used in the actuator shown in Figure 1, in three different operating states (a), (b), and (c);

Figure 3 is a longitudinal section view comparable to Figure 1, showing a variant of the first embodiment of the invention;

Figure 4 is a view comparable to Figure 3, showing another variant of the first embodiment of the invention; and

Figure 5 is a longitudinal section view of a downhole actuator of the hydraulic type, illustrating a second embodiment of the invention.

Detailed description of embodiments of the invention

In Figure 1, reference 10 designates a segment of production tubing mounted in the bottom of an oil or gas well (not shown). An adjustable flow rate valve 12 driven by an actuator 14 is installed on the segment of tubing 10. More precisely, the actuator 14 is designed to remain down the well for a period that is very long, e.g. about 5 years, without undergoing any maintenance.

The adjustable flow rate valve 12 comprises at least one opening 16 provided in the segment of production tubing 10, and a sleeve 18 suitable for sliding on the segment 10 parallel to its axis. More precisely, the sleeve 18 is mounted on the outside of the segment 10. As indicated by arrows F in Figure 1, the sliding of the sleeve 18 on the segment of production tubing 10, is controlled in continuous manner by the actuator 14. Such sliding makes it possible to uncover the openings 16 entirely or partially, and to do so in controlled manner.

In the first embodiment of the invention shown in Figure 1, the actuator 14 is an electromechanical actuator. This actuator comprises a tubular housing 20 receiving drive means. In the example shown, the housing 20 is fixed to one side of the segment of production tubing 10, parallel to the axis thereof. The housing 20 has an open bottom end facing the sleeve 18, and it is closed at its top end by a fluid-tight partition 22.

An electronic module (not shown), generally situated above the actuator 14 and at atmospheric pressure, electrically powers the actuator via electrical conductors 32 passing through the partition 22 in fluid-tight manner.

In this example, starting from the fluid-tight partition 22, the drive means comprise a motor and gearbox unit 24 and an output shaft 28 which leads into a chamber 30 filled with a hydraulic fluid. When the motor

unit 24 is switched on, it rotates the output shaft 28 at a low and controlled speed.

A nut-forming intermediate member 34 is rotatably mounted in the chamber 30 along the axis of the housing 30, e.g. by means of bearings 35. The intermediate member 34 is engaged on the output shaft 28 via its top end. It is provided with a bore 36 opening out downwards, and extending over most of its height. At its bottom end, the bore 36 is tapped so as to engage on a moving member 38 in the form of a threaded rod via a screw-and-nut type coupling 40, e.g. running on ball bearings. The moving member 38 is also centered on the axis of the housing 30. Its bottom end is fixed to a projection 42 on the sleeve 18.

In the above-described configuration, the output shaft 28 rotating as a result of the motor unit 24 being switched on causes the intermediate member 34 to rotate identically inside the chamber 30. Since the moving member 38 is secured to the sleeve 18, it is prevented from rotating about its own axis. As a result, the intermediate member 34 rotating causes the moving member 38 to move in translation along the axis of the housing 20, i.e. parallel to the axis of the segment of production tubing 10. As a result, the sleeve 18 moves in the direction corresponding to arrow F.

In the invention, the sealing between the bottom of the well and the zone inside the housing 20 that corresponds to the chamber 30 filled with hydraulic fluid is achieved by means of a metal sealing bellows 44 that is relatively small in diameter.

In addition, the changes in the volume of the chamber 30 due to the moving member 38 being moved along its axis, and the variations in pressure and in temperature in the well are advantageously compensated by a metal compensation bellows 46 that is relatively large in diameter. In other words, the compensation bellows 46

makes it possible to maintain the fluid contained in the chamber 30 and the downhole fluid at the same pressure.

In the embodiment shown in Figure 1, the sealing bellows 44 and the compensation bellows 46 (both of which are fluid-tight) are mounted in end-to-end alignment between the bottom end of the moving member 38 and the open bottom end of the housing 20.

More precisely, the top end of the compensation bellows 46 is fixed in fluid-tight manner directly to the open bottom end of the housing 20. The compensation bellows 46 is terminated at its bottom end by a radial wall 48 angularly positioned perpendicularly to the axis of the bellows and in which a central circular opening is provided. The top end of the sealing bellows 44 is fixed in fluid-tight manner to the rim of the central opening in the above-mentioned wall 48, and the bottom end of the sealing bellows 44 is fixed in fluid-tight manner to the bottom of the moving member 38 (or to the projection 42).

In practice, the bellows 44 and 46 are preferably made of stainless steel. They may be manufactured, in particular, by hydroforming, by electroplating, or in the form of welded undulations.

The behavior of the bellows 44 and 46 is explained in more detail below with reference to Figure 2.

In Figure 2, (a) designates the state of the bellows 44 and 46 when the valve 12 is fully closed, and (b) and (c) designate the state of the same bellows when the valve 12 is fully open.

Between the state when the valve 12 is totally closed, shown at (a), and the state when the valve is totally open, shown at (b) and at (c), the bottom end of the sealing bellows 44, as fixed to the bottom of the moving member 38, moves upwards over a distance d1 equal to the stroke of the sleeve 18. At the same time, the radial wall 48 moves in the opposite direction, i.e. downwards, over a distance d2. This movement corresponds to the compensation bellows 46 expanding to the extent

necessary in order to take into account the reduction in the volume of the chamber 30 resulting from the moving member 38 rising inside said chamber.

View (c) of Figure 2 shows that the radial wall 48 may also move, e.g. over a distance d3, independently of operation of the actuator. This type of movement corresponds to compensation of any variations in pressure and/or in temperature in the well, also performed by the compensation bellows 46 because of the difference between the diameters of the two bellows. This type of compensation, shown in this example when the valve is open, is performed regardless of the position of the valve.

A variant of the first embodiment of the invention is described below with reference to Figure 3.

Essentially, this variant differs from the above-described embodiment by the fact that, instead of being mounted end-to-end, the sealing bellows 44 and the compensation bellows 46 are totally dissociated.

More precisely, the bottom end of the sealing bellows 44 remains fixed to the bottom of the moving member 38 (or to the projection 42), but its top end is fixed directly in fluid-tight manner to the open bottom end of the tubular housing 20.

In addition, the radial wall 48 of the compensation bellows 46 has no opening, and the top end of the bellows is fixed in fluid-tight manner to the projection 42, in alignment with the moving member 38. The volume defined inside the compensation bellows 46 is then connected to the chamber 30 via a duct 50 which passes through the entire length of the moving member 38 and through the projection 42.

In another variant embodiment (not shown), the compensation bellows 46 may be mounted above the fluid-tight partition 22. The inside volume of the bellows 46 is then connected to the chamber 30 via a duct passing through the top portion of the housing 20.

Another variant of the first embodiment of the invention is shown in Figure 4, and it principally differs from the variant shown in Figure 3 by the fact that, instead of being placed beyond the bottom end of the housing 20, the moving member 38 is situated between the top and bottom ends of the housing.

In this case, the moving member 38 passes through an oblong opening 43 provided in the housing 20. This opening makes it possible for the member 38 to move along the longitudinal axis of the well when the actuator 14 is caused to operate.

This configuration leads to two sealing bellows 44a and 44b being used, disposed respectively above and below the moving member 38. More precisely, the sealing bellows 44a connects the top end of the nut which, in this case, constitutes the member 38 to a portion of the housing 20 situated immediately below the motor unit 24. In addition, the sealing bellows 44b connects the bottom end of the nut forming the member 38 to a bottom partition 21 of the housing 20.

In view of this configuration, the volume of the zone 30 filled with hydraulic fluid remains almost unvarying. This zone is defined between the housing 20 and the motor unit 24 and between the threaded rod (forming the intermediate member 34) and each of the bellows 44a and 44b.

In this case, that end of the compensation bellows 46 which is opposite from its radial wall 48 may be fixed directly to the bottom face of the partition 21, as shown in Figure 4. The bellows 46 then communicates with the zone 30 via the bearing 23 serving to support the bottom end of the threaded rod 34 in the partition 21.

In a variant, the compensation bellows 46 may also be mounted above the fluid-tight partition 22, as indicated above.

In the embodiment described above with reference to Figure 1, and in the above-mentioned variants, it should

be noted that, instead of being mounted in a tubular housing 20 fixed to one side of the segment of production tubing 10, the drive means (including the motor unit 24 in this example) may be disposed in an annular space formed between the segment of tubing 10 and a tubular housing mounted coaxially about the segment. In which case, the moving member 38 may also be a tubular member surrounding said segment of tubing 10 coaxially.

A second embodiment of the invention is described below with reference to Figure 5.

The second embodiment relates to the case of a downhole actuator 114 that is of the hydraulic type. As above, the example shown is applied to driving an adjustable flow rate valve 112.

In the embodiment shown in Figure 5, the drive means comprise a hydraulic actuator 124 suitable for being actuated by a pump 152 or by any other pressure source.

More precisely, the hydraulic actuator 124 comprises a cylindrical housing 120 and a piston 154. The piston 154 is secured to a tubular moving member 138 slidably mounted coaxially inside the cylindrical housing 120. The piston 154 co-operates with the inside surface of the cylindrical housing 120 via a first sealing gasket 156. On either side of the piston 154, the annular spaces formed between the cylindrical housing 120 and the tubular moving member 138 form the drive chambers 158 for driving the actuator 124. At its end opposite from the piston 154, each of the drive chambers 158 is defined by a respective partition 160 which is an integral part of the cylindrical housing 120. The drive chambers 158 are sealed by annular sealing gaskets 162 mounted in grooves formed in the inside of the partitions 160, so as to be in fluid-tight contact with the cylindrical outside surface of the tubular moving member 138.

Two pipes 164 open out into respective ones of the drive chambers 158 of the actuator, and they are connected in alternation to the delivery orifice of the

pump 152 via respective distributors 166. In addition, the suction orifice of the pump 152 is connected to an external fluid tank 168 via piping 170. The outlets of the distributors 166 that do not communicate with the delivery orifice of the pump 152 are also connected to the external fluid tank 168 via piping 172.

In the embodiment shown in Figure 5, the valve 112 is implemented in the form firstly of at least one opening 116 provided in a downwardly-projecting extension of the cylindrical housing 120, and secondly of a sleeve-forming bottom portion of the tubular moving member 138. The bottom portion is suitable for covering the openings 116 partially or totally or for uncovering them, depending on the position of the piston 154 inside the cylindrical housing.

In the invention, a respective metal sealing bellows 144 is interposed between each of the partitions 160 and the tubular moving member 138, on that side of the partition which is opposite from the side on which the drive chambers 158 are situated.

More precisely, a first end of each of the sealing bellows 144 is fixed in fluid-tight manner to the corresponding partition 160, and the second end of the same bellows is fixed in fluid-tight manner to the tubular moving member 138. The inside volume of each of the sealing bellows 144 thus communicates with a respective one of the drive chambers 158 through the corresponding sealing gasket 162. Said inside volume is also connected to the external fluid tank 168 via piping 176. In this way, the hydraulic fluid contained in each of the sealing bellows 144 is at a pressure equal to the pressure of the fluid in the well.

By means of the above-described configuration, even if the gaskets 162 leak, any penetration of the fluid from the well into the actuator 114 is prevented by the sealing bellows 144. In addition, there is no risk of the dynamic sealing gaskets coming into contact with sand

or any other corrosive material, and any oil loss is prevented. The actuator 114 may thus be used for a long period, e.g. several years, without any maintenance.

In another aspect of the invention, the external fluid tank 168 is defined at least in part by a compensation bellows 146, as shown diagrammatically in Figure 5.

In general, it should be noted that, although the variant embodiments described relate merely to driving valves, the actuator of the invention may be used for driving any other moving member down a well without going beyond the ambit of the invention.

Furthermore, it is possible for the moving member driven by the actuator not to be secured directly to the part that is to be moved. Thus, and merely by way of example, a motion-transforming mechanism may be interposed between the moving member and the actuator, and a rotary part may make it possible to use the actuator of the invention for driving a rotary valve.

CLAIMS

1/ A downhole actuator including drive means (24, 124) suitable for moving a moving member (38, 138) relative to a stationary housing (20, 120) in a longitudinal direction of the well, at least one zone (30) of the housing containing a fluid at a pressure substantially equal to the pressure down the well, said actuator being characterized in that it further includes at least one sealing bellows (44, 144) interposed in said direction between the housing (20, 120) and the moving member (38, 138), the sealing bellows (44, 144) defining at least a portion of said zone.

2/ An actuator according to claim 1, further including a compensation bellows (46, 146) connected to said zone (30), and including a radial wall (48) subjected to the downhole pressure.

3/ An actuator according to claim 2, in which the sealing bellows (44) and the compensation bellows (46) are mounted in end-to-end alignment, one end of the compensation bellows (46) being fixed to the housing (20), and the sealing bellows (44) connecting the moving member (38) to the rim of a central opening provided in said radial wall (48) of the compensation bellows (46).

4/ An actuator according to claim 2, in which the sealing bellows (44, 144) connects the moving member (38, 138) to the housing (20, 120), and the compensation bellows (46, 146) communicates separately with said zone (30).

5/ An actuator according to claim 4, in which, with the moving member (38, 138) being placed beyond one end of the stationary housing (20, 120), the sealing bellows (44, 144) connects the moving member (38, 138) to said end.

6/ An actuator according to claim 4, in which, with the moving member (38) being placed facing an opening (43) provided in the stationary housing (20), two sealing bellows (44a, 44b) connect the moving member (38) to the housing (20), on respective sides of the opening (43).

7/ An actuator according to claim 5, in which that end of the compensation bellows (46) which is opposite from the radial wall (48) is fixed to a portion of the moving member (38) that is situated outside the housing (20), and a duct (50) is provided through the member to connect said zone (30) to the compensation bellows (46).

8/ An actuator according to claim 5 or 6, in which that end of the compensation bellows (46) which is opposite from the radial wall (48) is fixed to an end of the housing (20), and communicates with said zone (30).

9/ An actuator according to any one of claims 2 to 8, in which the sealing bellows (44) and the compensation bellows (46) are made of stainless steel.

10/ An actuator according to any preceding claim, in which the drive means comprise an electric motor (24) housed in the housing (20), an intermediate member (34) being rotatably mounted in the housing, and being suitable for being rotated by the electric motor, said intermediate member being engaged on the moving member (38) via a screw-and-nut type coupling (40).

11/ An actuator according to any preceding claim, in which the housing (20) is fixed to one side of a segment of production tubing (10) and parallel thereto.

12/ An actuator according to any preceding claim, in which the housing (20) surrounds a segment of production tubing (10) coaxially.

13/ An actuator according to any one of claims 1 to 9, in which the drive means comprise a hydraulic actuator (124) actuated by a pressure source (152), the moving member (138) being secured to a piston (154) of the actuator, which piston is suitable for sliding in fluid-tight manner in said housing (120) while defining at least one pressure chamber (158) connected to the pressure source (152), said zone being formed outside said chamber, being separated therefrom by at least one sealing gasket (162), and being connected to a fluid tank (168) defined at least in part by the compensation bellows (146).

14/ A device for adjusting downhole flow rate, said device including an actuator (14, 144), a segment of production tubing (10, 110) in which at least one opening (16, 116) is provided, and a sleeve (18, 138) mounted to slide relative to said segment, the actuator (14, 114) including drive means (24, 114) suitable for moving a moving member (38, 138) secured to said sleeve (18) relative to a stationary housing (20, 120) secured to said segment in a longitudinal direction of the well, at least one zone (30, 130) of the actuator containing a fluid at a pressure substantially equal to the downhole pressure, said device being characterized in that it further includes at least one sealing bellows (44, 144) interposed in said direction between the housing (20, 120) and the moving member (38, 138), the sealing bellows (44, 144) defining at least one portion of said zone.

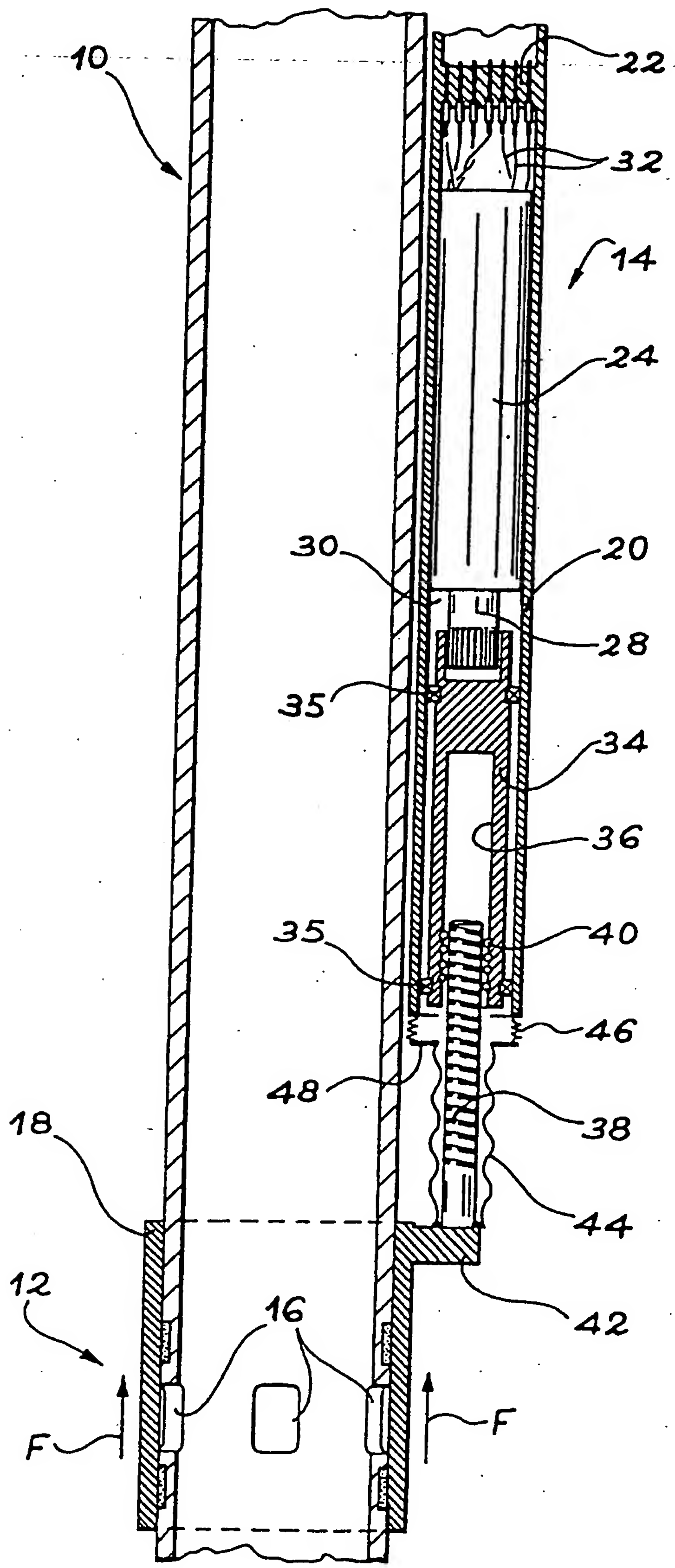

FIG. 1

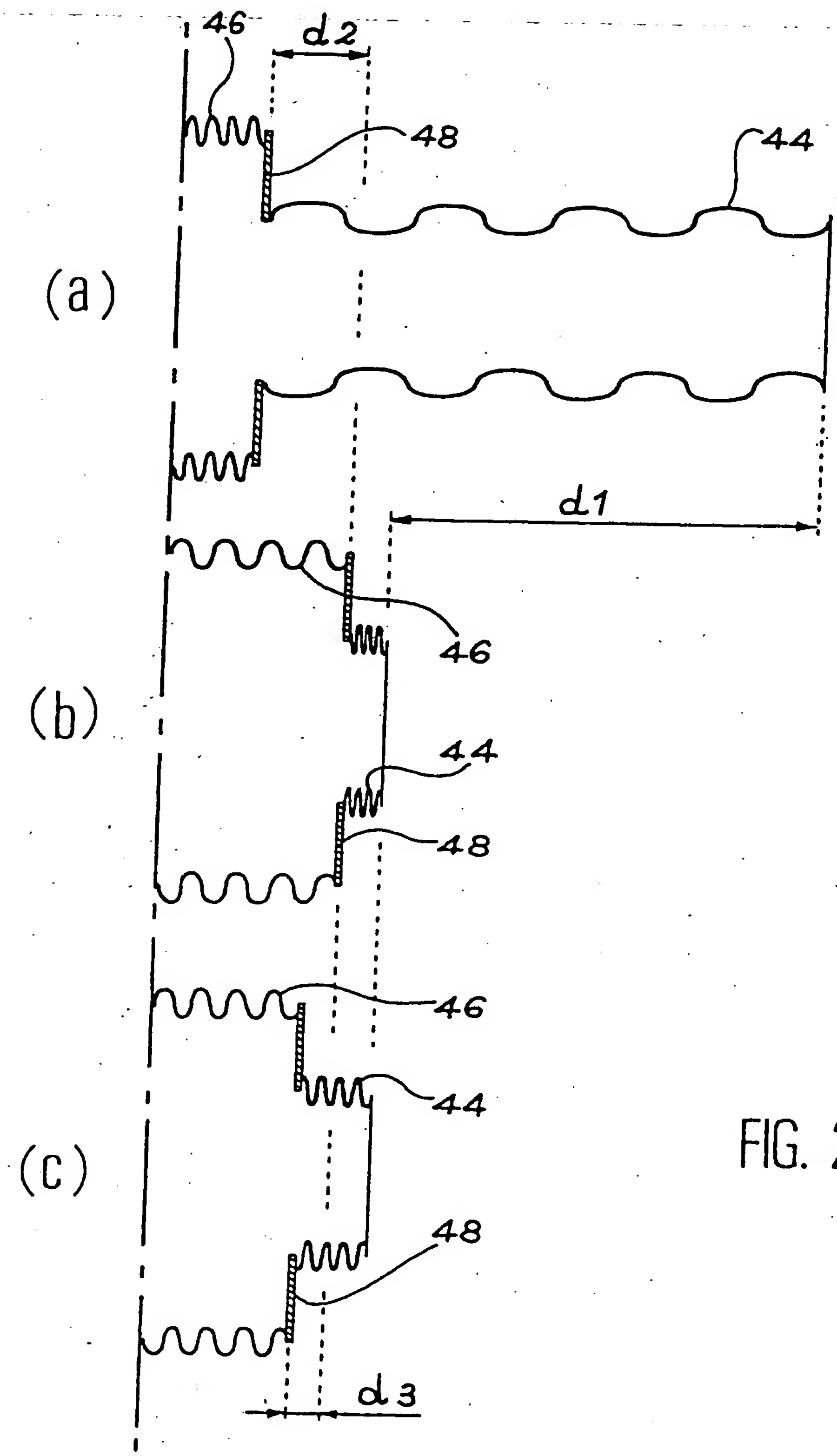

FIG. 2

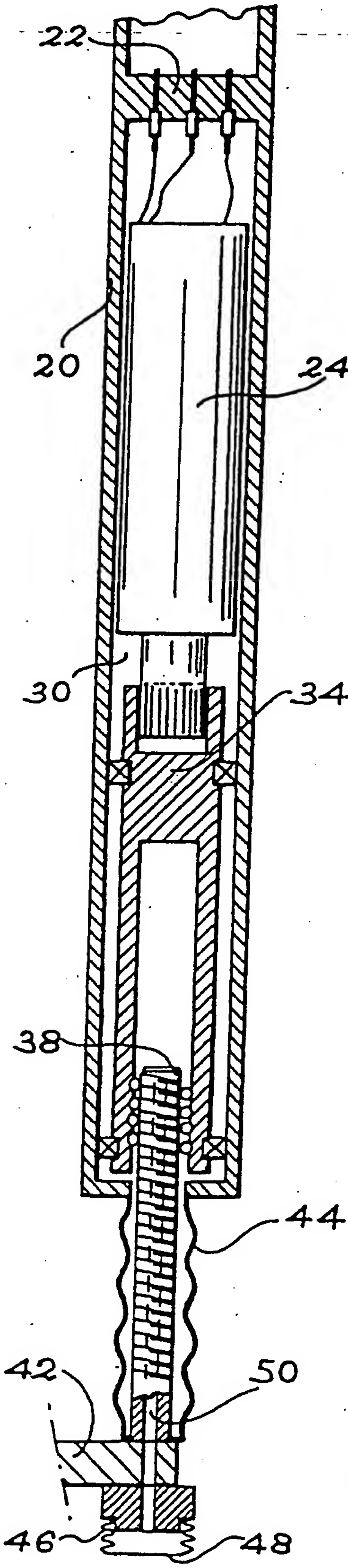
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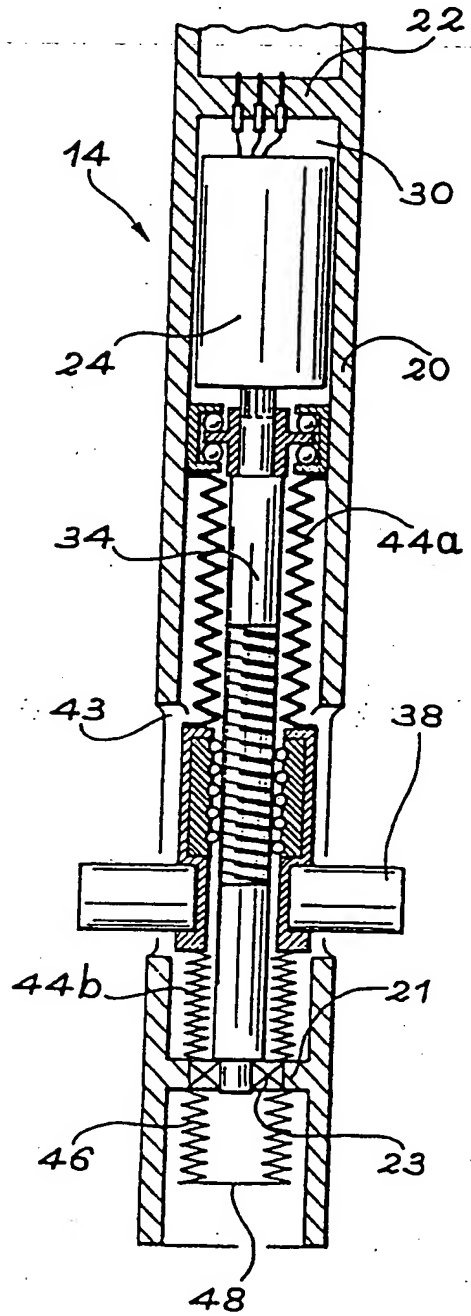
FIG. 3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44b
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FIG. 4

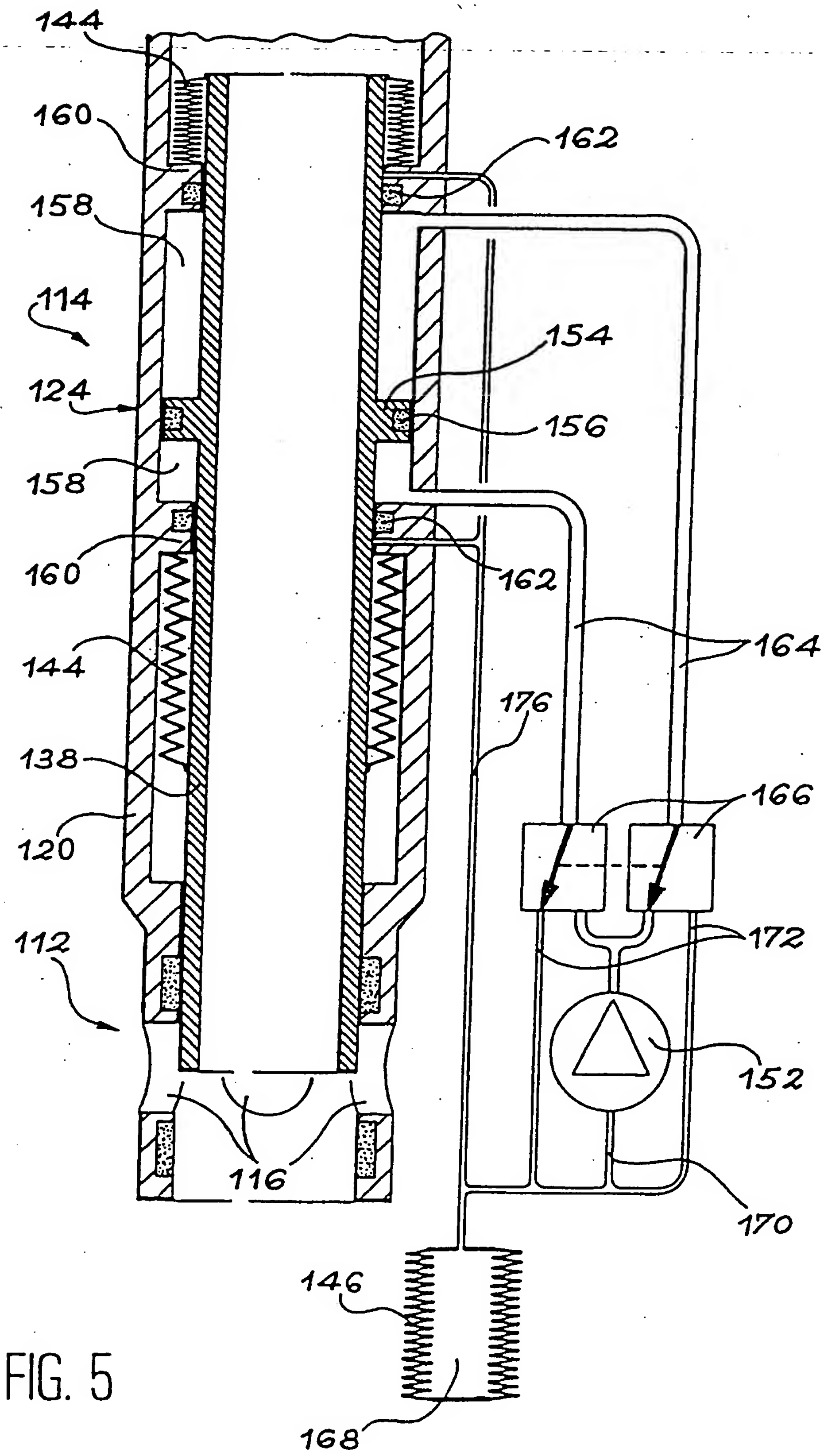
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FIG. 5

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 00/01552

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B34/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 467 870 A (LANGHAM RONALD F) 28 August 1984 (1984-08-28) column 6, line 24-32 figures 5,7	1,14
A	US 5 299 640 A (STREICH STEVEN G ET AL) 5 April 1994 (1994-04-05) figure 4	1,14

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 June 2000	26/06/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Schouten, A

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 00/01552

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 4467870	A	28-08-1984	NONE		
US 5299640	A	05-04-1994	EP	0594390 A	27-04-1994
			NO	933717 A	20-04-1994